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THE MANCHURIAN TRIANGLE

ITS PHYSICAL BACKGROUND

By PROFESSOR FREDERICK K. MORRIS

Professor of Structural Geology, Massachusetts Institute of Technology

THE physical structure of any country is our first clew to the human problem there. Manchuria is a basin land with a sunken center that forms broad lowland plains, surrounded by uplifted mountains that are the basin's rim, and which enclose the basin lowland on all sides but the south, where the central plain flattens down to sea level. Here the silty delta of the Liao River meets the muddy Gulf of Liaotung, and forms the broad natural entrance to the basin of Manchuria.

The western rim of the basin is the Great Khingan range, rising in places 12,000 feet above the basin's floor. At the southern end the mountains touch the very sea, leaving only a narrow gateway—just room, between mountains and sea, for a road and a railroad to connect the flat delta plain of China proper and the flat Manchurian delta of the Liao. This narrow pass is a Thermopylae, where a handful of resolute men on either side might stop an invading army. Or if an army were rash enough to break through the pass in either direction and invade the broad plain of either China or Manchuria, its communications would be so meager and so easily destroyed, that the invaders would have sealed their own doom—as Austria sealed hers in 1917 by spreading out her forces over the plain of Northern Italy, though she had three Alpine passes at her back instead of only one. The perilous Manchurian pass has been named Shanhaikwan, "the guard of mountain and sea," and its strategic value has been known for ages, for here, at the very shore, begins the great wall of China.

Continuing our journey northward along the Great Khingan barrier, we reach a pass connecting the Gobi basin with that of Manchuria. The Khailar River flows down the western side of the range, exactly opposite to where the Yan River descends the eastern slope to join the Nonni just below Tsitsikhar. The headwater-valleys of the two streams have cut a low gap in the range, and here the Russians have carried the railroad through at an elevation of 3460 feet. The northern end of the Great Khingan is a splendid wilderness of forested mountain ridges, from which a long spur range called the Ilkhuri Alin diverges toward the southeast, enclosing the headwaters of the Nonni. At the southeastern end of the Ilkhuri Alin there is another pass at about 1800 feet, leading from Mergen on the Nonni to Aigun, just below Blagovieshchensk on the Amur. The Russians have made a road and partly built through the gap. Just east of this pass the rimming mountains continue, but are called the Little Khingan. They form a forbidding wall for 300 miles further toward the east to where the Sungari River rolls through a water gap in the mountains, draining two-thirds of Manchuria northward into the Amur. An important trade route follows this gap, from Harbin to Khabarovsk on the Amur, but the railroad has not been built.

On the east, the rim of the basin is formed by a host of ranges which I shall call collectively the East Manchurian Highland. It is pierced by several chains of passes, chief of which is the direct railroad route from Harbin to Vladivostok. Here is the first foundation of Russia's interest in Manchuria. From Chita in Siberia, the railroad runs across Manchuria to Vladivostok in a nearly straight line, clipping six hundred miles from the roundabout northern route from Chita along the Amur to Vladivostok.

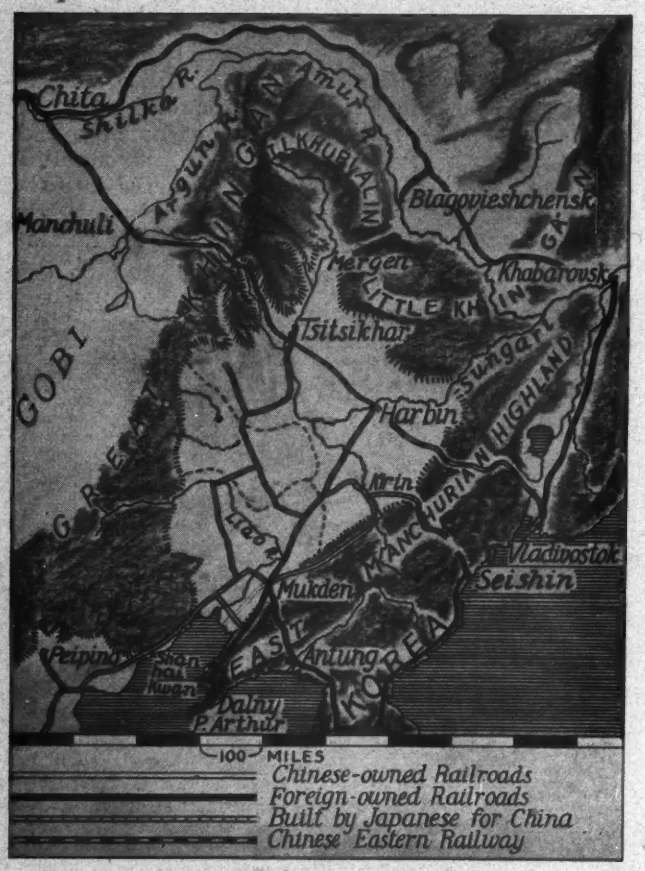
At the very southern end of the East Manchurian Highland is the tortuous gap that leads from Mukden across the hills to Antung on the Yalu River, at the Korean border. South of the Mukden-Antung pass the East Manchurian Highland continues to its end in the rocky promontories about Dalny and Port Arthur—forming good harbors with formidable defenses, as the battles there have proved.

Between the two passes leading respectively to Vladivostok and to Antung there is a third pass, through the Highland, followed by a road and an unfinished railroad, leading from Kirin to Seishin in the northernmost tip of Korea. This gateway is a future value which makes it one of the present bones of contention.

The floor of the great basin is not a unit, but is divided into three unequal shallow compartments—like the blue plates in restaurants. The northern basin is by far the largest and is drained northward to the Amur by the Nonni-Sungari River system. The southern basin drains southward through the Liao and other small rivers. The western basin has no outward-flowing rivers. Its water escapes by evaporating from shallow lakes.

The northern basin owes almost its entire development to Russian enterprise. It contains forests, water power, coal, some gold, and most of the straight short cut to Vladivostok. The soil is rich, though the growing season is short, and grain, cattle and sheep are abundantly produced. Not only are farmers and workers flocking to the northern basin, but they and the original inhabitants are finding new needs; for motor cars instead of ox carts; for roads instead of trails; for kerosene lamps, and even electricity; for better food, houses and implements. The exports of grain, cattle, timber and coal, and the growing import of cloth, implements and machinery are all made possible solely by the Chinese Eastern Railway.

Russia acquired the right to build this railway in 1896. The money came almost wholly from Russia, for the Russians desired a monopoly. In 1924 the management of the railroad was thoroughly reorganized, giving the Chinese a nearly equal voice with the Russians in its administration. It is important to note that, though a Chinese Foreign Minister negotiated this treaty, it was void, since China had not effective control of Manchuria, and a separate treaty had to be concluded between the Soviet and Chang Tsolin at Mukden.



MANCHURIA TODAY

The mountain areas are shaded, the lowlands left white. The Manchurian basin is enclosed between mountains on all sides except at the southern end where the flat delta of the river Liao opens to the Yellow Sea. The three minor basins within the Great Lowland are enclosed by broken lines—the northern basin, drained by the Sungari River and its tributaries; the southern basin draining to the Yellow Sea, and the western basin, draining into terminal lakes.

Chang Tsolin and his successor, Chang Hsuehliang, compelled the railroad by force to transport Chinese guards and troops free, to deposit half the profits in Chang's bank—which was equivalent to giving them to Chang—to give over its river steamers, its telephone and telegraph lines and to dismiss Russian officials. Direct attacks were made upon Russians, even including invasion of Russian territory.

Besides the railroad, Russia owns and operates mining, timbering and other concessions which require the railroad for their maintenance. She has built excellent cities, notably Harbin. But beyond all of these local enterprises, the railroad brings Russia's rich maritime provinces 600 miles nearer to Chita than does the all-Siberian railroad along the Amur. That Russia will never give up this vast advantage, the work of Russian brains and capital, is certain.

The southern basin is far smaller than the northern, but enjoys a milder climate and a longer growing season. Here are broad plains which produce huge crops of soy beans as well as millet, wheat, potatoes, corn and even some rice and cotton. In the hills east and west of the lowlands coal is abundant and excellent. Iron is scarce. Lead, silver, zinc, and a little gold are found, but no metal is abundant. The rainfall in the south, especially in the East Manchurian Highland, is heavy enough to provide good water power, though far below that which our opulent rivers yield.

How have the two southern peoples answered the challenge which the physical opportunities of such a land offer them? We need not review here the story of Japan's war with China, beyond reminding ourselves that China's actions made the war inevitable. Japan gained control of South Manchuria only, and not of the northern basin. Her hold was broken at once by the joint "friendly" intervention of Russia, Germany and France. When Russia seized it in 1896, Manchuria was a true pioneer country—almost a no-man's land. The vast area of 380,000 square miles held less than 5,000,000 people. Russia first, and Japan later, opened the country. Japan has studied the soils, introduced crops, fostered trade, built good roads and railroads which run like clockwork. She has opened mines and planted forests. She has maintained order and a higher justice than I know of in any other oriental country. The prosperity of the land is due chiefly to Japan's work. Yet Japan actually controls only a small portion of the country.

China has taken advantage of the opportunities thus created, to colonize Manchuria. Floods of farmers and workers have poured in, chiefly during the last two decades, increasing the population by twenty millions. China, too, has built railroads, partly with Chinese capital, partly with loans from Japan. She also has developed mines. Her active interest in the country has come actually later than that of either Russia or Japan. Politically the Chinese portion of Manchuria is autonomous—it is not a part of China as New England is a part of the United States. Even in its independence, Chinese Manchuria is not united, but is cut by internal warfare and dissension. Bad as the administration is, the excellent farming, and the frugal, hardworking lives of the Chinese make Chinese Manchuria a wealth-producing region. China has answered the land's challenge chiefly with the plow.

THE MODERN UNIVERSE

By Dr. Robert H. Baker

Professor of Astronomy, University of Illinois
Research Associate in Astronomy, Harvard University

The physical universe as it is known today is contained within a spherical region having the earth as its center, and a radius of two or three hundred million light years—or something like 10^{21} miles. In whatever directions the largest telescopes are pointed, save where the great cosmic dust clouds interrupt the view, we find arrays of celestial bodies out to this limiting distance.

Stars like our sun are the principal building blocks of the universe. Great balls of highly heated material, they are also the power houses of the universe, from which energy is dissipated in amazing quantity. How they can continue to produce the energy which they spend in undiminished shining, century after century, is one of many problems on which astronomers and physicists must combine forces. These celestial building blocks have different surface temperatures, and therefore are of different colors, varying from blue stars such as Vega to red stars, such as Betelgeuse and Antares. They contain, in general, about the same amount of material, and the same kinds of material—the same familiar chemical elements—that we find in the earth.

While the stars exhibit remarkable uniformity in their masses, they differ enormously in their diameters. The sun's diameter is nearly a million miles. Antares is five hundred times larger. Near the other extreme, the faint companion of Sirius is not much larger than the earth. Consequently, the stars differ enormously in their densities. Antares averages only 1/3000 the density of the air around us whereas the mean density of the companion of Sirius is tens of thousands times the density of water. In these respects the blocks are far from uniform.

Southern region of the Milky Way. The Southern Cross and the Coalsack are near the center.

The Small Magellanic Cloud. One of the nearest galaxies at the distance of 95,000 light years. Its diameter is 6,000 light years.

Gravitation is the cement that makes for stability in the celestial structure—gravitation combined with the motions of the bodies which prevent them from assembling into a single great lump. Collisions are not a considerable item in the wear and tear. The interstellar and intergalactic spaces are so vast that major catastrophes of this sort are practically negligible. Dissipation of energy in the radiations of the stars may in time affect the structure. No one knows as yet. But if it is true that the stars are shining at the expense of their masses, then the sun alone is losing more than two million tons of its material every second.

Additional building material is provided by the nebulae. These great clouds of gas and dust, and presumably of larger pieces also, are found in many parts of the heavens. They are especially noticeable in the direction of the Milky Way where they produce by obscuration the "dark rifts" in the starry background. A long dark cloud is projected nearly centrally against this luminous stream along a third of its course around

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SAINTS OF CHEMISTRY

By Professor Henry M. Smith.
Professor of Inorganic Chemistry, Massachusetts Institute of Technology

In his extremely entertaining autobiography "From Immigrant to Inventor" Professor Pupin tells us that his pious mother was accustomed to refer to his professors at Cambridge as his "Saints," and he then adds, "our American colleges and universities should have days consecrated to the memories of what Maxwell called the fathers of the sciences, like Copernicus, Galileo, Newton, Faraday, Maxwell, Darwin and Helmholtz. I mention these names, having the physical sciences in mind, but similar names can be mentioned in other departments of human knowledge. Why should not science follow the beautiful example of religion which has its saints' days?"

It was a somewhat similar thought that led to the beginning of the collection of the "Saints of Chemistry" that has been gradually expanding on the walls of the first and second floors of Building 4 for the past few years.

The first dozen or so pictures to be hung were secured from a German publishing firm in 1925 and bore only the name of the subject. The following year the late Professor F. J. Moore, whose interest in the history of chemistry is well known, kindly consented to write some legends to be attached to these pictures. These legends were brief, of less than fifty words, giving an estimate of the man and his work, but they produced a noticeable increase in the interest in the pictures as shown by the students pausing to look at them in passing through the halls. This increased interest has encouraged the preparation of longer biographies for the later additions, giving the field of work, the principal contributions with dates and perhaps some personal incident from the subject's life. There are now 204 pictures complete with legends in the collection.

The Synthesis of Alizarin
Hofmann *Graebe* *Liebermann*

The expense for the continued additions to this collection have been met from a fund placed at the disposal of the Department of Chemistry by Mrs. F. J. Moore in 1927 (?). Though these pictures are mostly of chemists, there are a number of physicists included, for to paraphrase Bunsen's famous statement, "Ein Physiker der kein Chemiker ist, ist uberhaupt gar nichts."

The sources of these pictures are varied: some have been found in old bookshops in Paris, others in old scientific journals, some are from portraits or prints in the galleries of Europe; and many of the staff of the Chemistry Department have loaned photographs for copying from their private collections. These have all been reproduced in uniform size of 14 x 17 inches.

While it was intended that the collection should include only the photographs of those whose work is over and who have been "canonized," a few pictures of living scientists have been included for one reason or another.

The pictures have been on the whole well treated by the public, none have been injured and only one has been stolen. A witty caricature once appeared in the collection, made by hanging over the photograph of Arrhenius a print of "La Chimiste" by the Dutch artist Matsys, which represents an alchemist asleep at the window of his laboratory. The legend ran in part as follows:

"Lemmy Snooze: D.T. D-z-z-z-z. Grandfather of Chemistry. Studied under Morpheus and Somnus and discovered that energy is best conserved by not using any. . . . Snooze is shown above in characteristic pose wondering why his stenog hasn't returned with that next pint." The work was cleverly done and no damage resulted to Arrhenius' picture, so the Chemistry Department has forgiven the perpetrator of the joke.

Mrs. Moore's gift has also made possible the beginning of a collection of medals. There are now fifty of these temporarily placed on exhibition in a case in room 4-258. These medals for the most part commemorate some discovery or event of scientific importance or are copies of medals presented by scientific societies to honor the recipient.

The picture entitled *The Synthesis of Alizarin* has been the object of much debate and of an interesting search to trace its history. It is an oil painting 4 x 6 feet by Anna M. Lea, dated 1869, and came into the possession of the Chemistry Department more or less as an outcast. When the Institute moved from Boylston Street this painting was found in a storage room and was hung in the dining room of Walker, where it remained until two years ago. When the portraits were rearranged in Walker this one was removed and possibly because of the bottles and reagent glasses on the table it was supposed to represent some of the early members of the chemistry staff and so came into the possession of the Department of Chemistry. Be that as it may, the painting has been restored and now hangs in the office of Professor Keyes. It is believed that the

central figure is that of Hofmann who, because of his studies of the derivatives of coal tar, may, in a broad sense, be regarded as the founder of the coal-tar dye industry. Hofmann was also the founder and for many years the president of the German Chemical Society. It is thought that the figure sitting on his right is that of Graebe while Liebermann stands on his left. Graebe and Liebermann jointly developed the process for the artificial production of the dye alizarin, commonly called "turkey red." It was on January 11, 1869, that Graebe and Liebermann announced their discovery before the members of the German Chemical Society, with Hofmann as presiding officer in the chair. This date is an epochal one in industrial chemistry for it marked the first artificial production of a natural plant dye, and the discovery made a great sensation in the chemical world. That the painting commemorates this event is our conjecture, not only from the resemblances in the faces of the men and from the date 1869, but from the presence of the piece of coal in Hofmann's hand, the autoclave on the table and the shades of the dyed cloth, for turkey red requires a mordant and gives different shades with different mordants.

How did the painting come into possession of the Institute? That question to date remains unanswered. Mr. MacDonald of the Buildings and Power Department says that when he came to the Institute in 1897 the picture hung in the office of President Walker, and that it hung there during the terms of office of Presidents Crafts and Pritchard and that it was later removed to the general library. Mr. Pritchard writes that he has no recollection of the picture. Mr. Charles Cole, our chemistry lecture assistant, recalls that it hung on the top floor of the Pierce building near the entrance to the Industrial Chemistry Laboratory for several years following 1902. Apparently it was removed for storage about 1905. Many attempts to learn the history of the picture from the artist were unsuccessful, and when after two years' effort her married name and address in England was secured a letter of inquiry brought the reply from her executor that Mrs. Anna Lea Merritt had died six months previously, but that a sister was residing in New York. This lady in reply to an inquiry wrote, "My sister Anna M. Lea was painting in Dresden and Paris in 1869" and "that as my father through his business interests had something to do with coal-tar dyes, this picture may have been an outcome of that interest."

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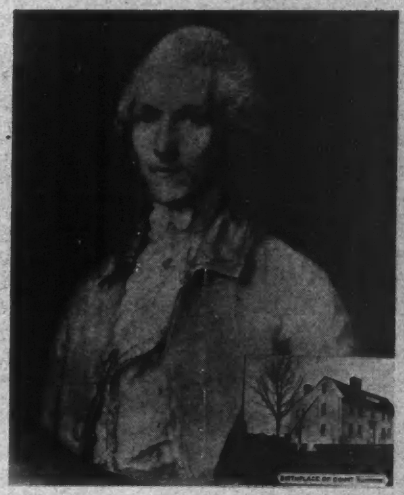
Johann Rudolph Glauber: 1604-1670.

Called the first industrial chemist. Born in Germany, resided in Amsterdam (1646-1649) (1655-1670) where he published his "Furni Novi Philosophie" (1648-1650), "one of the most remarkable books on chemistry of the XVII century." Prepared hydrochloric acid from rock salt and oil of vitriol; fuming nitric acid from saltpeter and white arsenic; discovered ammonium nitrate and first prepared arsenic chloride. Prepared the chlorides, nitrates, sulphates and acetates of the different metals, studied their properties and suggested uses. First definitely stated the order of activity of the metals. Made acetic acid by wood distillation; improved the methods of fractional distillation and separated acetone and benzene (1648) from their raw distillates. Contributed to agriculture, medicine, paints, explosives, glass and porcelain. Complained that Germany sent her crude products to foreign countries for refining. Glauber's salt, sal mirabile Glauberi, has today important industrial uses.

Nicolas Leblanc: 1742-1806.

Pupil of Darcet and Rouelle. Friend of Fourcroy and Vauquelin. Physician to the Duke of Orleans. The growing need of soda in the industries led the Academy of Sciences to offer a prize for a commercial method for the production of soda from salt. Leblanc began his experiments in 1789, received patents in 1791, and borrowed funds of the Duke of Orleans to establish a factory. During the Revolution the Duke was beheaded (1793), the factory confiscated and patents annulled (1794). After the Revolution Leblanc endeavored to regain his property but was unsuccessful. Broken in mind and body, penniless and his wife ill, Leblanc shot himself in the poorhouse of St. Denis. Even his grave is unknown. In 1887 a monument was erected to his honor at the Conservatoire des Arts et Metiers, Paris.



Benjamin Thompson, Count Rumford: 1753-1814.

One of the most romantic characters in science. Born at North Woburn, Mass., taught school at Rumford (now Concord, N. H.), knighted by George III, made count of the Holy Roman Empire by Maximilian I. Experimented on the construction of firearms and the action of gunpowders. In supervising the boring of cannon he discovered the relation between heat and work and announced that heat was "not a fluid" as supposed, but "a mode of motion." Studied the conductance of heat through liquids, the expansion of water and of ice, and showed the influence which these properties exert on climate. Founded the Royal Institution (1800). Married (1805) Lavoisier's widow. Buried at Auteuil near Paris. Left bequests to Harvard University, the American Academy of Arts and Sciences, and the Royal Society of London. His birthplace, 13 miles north of Boston, is preserved as a museum.

AUTOMATIC FIRE PROTECTION

By George Henry '31

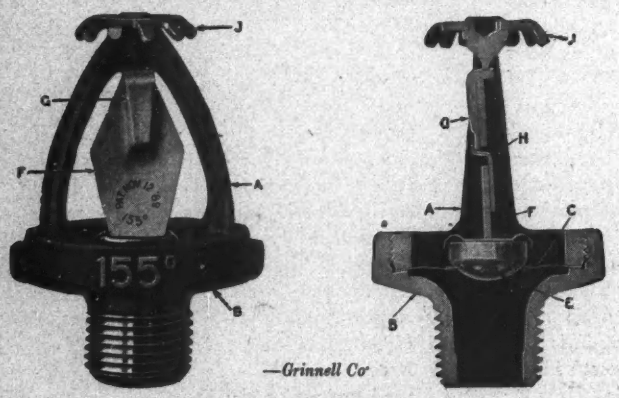
Fire continues to be the greatest individual destroyer of property in the United States although modern engineering and research are doing much to cut down the loss, both by prevention and by more effective extinguishing after fires have started.

Conflagration hazards exist in practically all the larger cities of the country; that is, there are large areas where a good blaze is very likely to burn over a whole section. Some of the major conflagrations of this type include the $168,000,000 Chicago fire started by Mrs. O'Leary's cow, the $50,000,000 Baltimore blaze, the $350,000,000 San Francisco fire in which 28,000 buildings were destroyed, and many others. In the three major Boston conflagrations some $81,000,000 in property was lost. In all there have been approximately 65 of these large fires since 1830, aggregating a loss of $1,000,000,000.

Since practically all fires could be kept from spreading if they were discovered and extinguished in time, engineers have for many years been working on systems of automatically detecting and extinguishing fires upon inception. Of all the methods developed, the automatic sprinkler system has proven itself to be the most efficient. Such a system comprises pipes of graduated sizes, permanently installed near the ceiling of the building to be protected, and connected to one, or when possible, two reliable sources of water supply. At intervals of eight to ten feet, automatic sprinklers are attached to the pipe and spaced so as to thoroughly wet 80 to 100 square feet of floor. Unless the building is unheated and freezing temperatures likely to be encountered, the system is "wet," that is, the sprinkler pipes are normally filled with water at sufficient pressure to insure effective discharge of not less than 15 gallons per minute from the highest sprinkler.

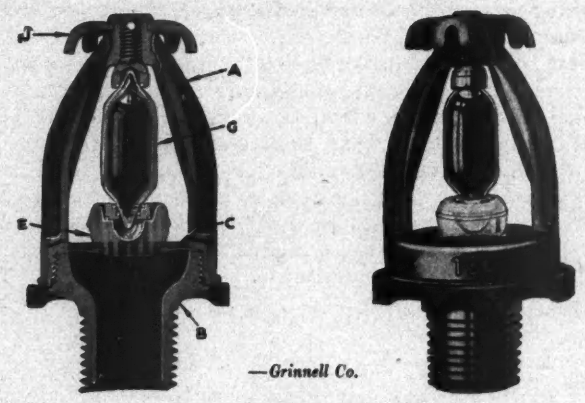
At the inlet of each system, besides a shut-off valve, there is installed an alarm valve. This is a check of special design so arranged that when a sprinkler has opened, an alarm is sounded within the building on an electric bell, and outside on a large gong.

When an unheated building is to be protected there is substantially the same arrangement of pipes and sprinklers, except that the alarm valve is replaced by a so-called "dry pipe valve" and the distributing pipes are filled with compressed air instead of water. The dry pipe valve is so constructed that an air pressure of from one-fifth to one-sixth the water supply pressure will maintain the valve closed and the system dry. When a sprinkler opens the air pressure falls, the dry valve opens, and water flows to the sprinklers, operating an electric and water motor alarm as in the case of the wet system.



—Grinnell Co.

Solder Type Sprinkler
Cross-section: A—yoke, B—body, C—diaphragm, E—glass valve, F, G, H—three-part strut held together by solder.



—Grinnell Co.

Quartz Bulb Sprinkler
Cross-section: A—yoke, B—body, C—diaphragm, E—glass button valve, G—quartz bulb, J—splash plate.

The most interesting and distinctive part of a sprinkler system is the automatic sprinkler itself. This comprises a small bronze casting, having at its base an orifice approximately one-half inch in diameter, surrounded by a one-half inch pipe thread, which serves to attach the sprinkler to the pipe system, and two upwardly branching arms joined together opposite the orifice, supporting a splash plate. An unstable system of small levers, held together by easily fusible solder, forces a circular valve plate tightly against the orifice, closing it effectively at normal temperatures against the air or water pressure in the system. On rise of temperature the solder holding the levers together melts, ordinarily at about 155°. The levers fly apart, the valve is free to lift, water issues from the orifice in a solid stream, and, impinging upon the splash plate, is scattered in all directions.

A widely used and familiar type of sprinkler has the orifice punched in a stiff bronze diaphragm, which is held between the body casting and the upper casting or yoke. A glass button-shaped valve seats upon the orifice and is held in place by a three-piece metal strut having compound leverage. As glass is non-corrodible, the valve cannot stick to its seat, and the system pressure, acting on the diaphragm, assists in making a tight joint. Normally the diaphragm is flexed downward, and on melting of the solder springs up, insuring a sharp, decisive parting of the strut members. Soldered strut sprinklers are made for normal use with an operating temperature of about 155° to 165°, and where higher temperatures are encountered, of 212°, 286° and 360°.

Although devices of this kind have proved satisfactory in actual service, they have certain inherent drawbacks. The fusion point of the solder is set higher than the ideal due to the fact that, if set much lower, it might soften in very hot weather and open the system. It is also subject to corrosion, which weakens and occasionally changes it to an infusible compound.

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ENGINEERING DIGEST

Condensations of outstanding articles in the leading trade and scientific journals, published by special permission.

The Autogiro, as I See It

By Harold F. Pitcairn

Condensed from Aviation, *November, 1931*

From an aeronautical innovation regarded with merely an academic interest on this side of the Atlantic, the autogiro has become the first fundamentally new type of heavier-than-air craft to give successful performances.

Developed by many years of concentrated work, including both engineering and flight testing, the new de La Cierva autogiro embodies a rotor starter, connected by clutch and shaft to the engine, which makes the take-off considerably shorter than that of an airplane. An improvement of the rotor blades and fixed wings are factors in the increased efficiency of the machine, while the landing gear is also both more substantial and light. Upturned wing tips now give the autogiro good lateral stability; directionally, sufficient fin area provides additional stability; proper location of the center of gravity, fixed wings and tilting of the engine lead to satisfactory longitudinal stability; and the total effect is to make the autogiro thoroughly stable, comparing favorably with the airplane. The rotor operates more smoothly and possesses not only the engine-driven starter but also a brake for stopping the blades after landing.

Picture the flying machine of the future as fantastically as you will, the basic principle of the autogiro is excellent. The speed of the lifting surfaces is maintained independently of the speed of the machine as a whole.

Directly as a result of this principle, the autogiro is able to maintain a minimum forward speed. Heavier-than-air craft are invariably supported by deflecting air downward. If lift and control are to be retained, the surface or surfaces deflecting air must move at a tremendous speed, since air weighs so little. In the airplane, slots and flaps of various sorts have been tried, but ultimately the forward propulsion and lifting power come from the same source. The autogiro can, on the other hand, have a zero minimum forward speed as compared with the 40 m.p.h., say, required by the airplane.

As more aero enthusiasts fly the new autogiro questions of handling are brought forward. Although a certain type of spectacular autogiro flying requires considerable skill and experience, ordinary autogiro flying is not difficult. About 75 airplane pilots have flown autogiros after only verbal instruction, with only one minor mishap due to a jammed wheel brake. In a newly formed novice school a number of men, ranging from 25 to 40 in age, made solo flights in about two-thirds the instruction time necessary for men of the same age in flying airplanes.

When an autogiro and a Mailwing airplane, both equipped with Wright J-5 engines, were given a climb test carrying the same gross load over a range of 1,800 feet, the obstacle cleared by the autogiro was 20 per cent the higher. The shorter the distance from the starting point, the sharper was the autogiro's angle of climb, comparatively. Repeated experimentation proved that the autogiro would not tail spin and that the bottom would not fall out even when it was brought to a standstill in the air.

My attitude toward the autogiro is strongly influenced by my own experience with it. For the past two months I have been using the autogiro, for the most part, in place of the car, flying daily from my front lawn to the factory in the morning and flying back again in the evening. I never seriously considered landing on the lawn in an airplane. I have commuted week-ends in the 'giro, landing on the beach in front of my house 80 miles away. This would have been impossible on quite a few occasions with an airplane because of the crowded beach and its narrowness at high tide. Several weeks ago, I flew from my home to the factory in weather so thick that I would not have ventured forth in an airplane. Flying at 40 m.p.h. I had ample opportunity to see and avoid obstacles, aided by the 'giro's facility in turning within an extremely short radius without danger of a tail spin or stalling.

One acquires a new conception of flying when he becomes familiar with the autogiro. Flying low and slowly with full control and ability to turn in a short radius gives a thrill of enjoyment without a feeling of danger. I am confident that the practical utility of the flying machine has at last arrived.

Carburization of Steel with Gas

By R. G. Guthrie

Peoples Gas Light & Coke Co., Chicago

Condensed from Metal Progress, *November 1931*

In the earlier forms of carburizing, the material to be carburized is heated in company with a carbonaceous material, consisting of bone or various kinds of charcoal together with re-activators, which will evolve a gas at the furnace temperatures. It is from this gas that the iron or steel absorbs sufficient carbon to raise the carbon content in the outer surfaces and thereby lend itself to the later treatment of hardening and tempering. Liquid carburizers, such as cyanides, and oils and other liquids have also been used as a source of carbon for case hardening.

It is interesting to note that, irrespective of the type of carburizer used, its final form, before giving up carbon to the steel, is always gaseous. But reactions during the evolution of gas from solid or liquid carburizers interfere materially with the maintenance of a comparable equilibrium between that carburizing agent and the iron and steel. It has also been found impossible to control the concentration of a given case per unit depth unless the carburizing medium is in the gaseous state. It was the realization of these facts that led to the selection of gas as a carburizing medium.

Early experiences with a 550 B.t.u. mixed coke oven and

carburetted blue water gas were disheartening from the standpoint of constancy of operation. For example: A given operation using 75 cu. ft. of gas per hr. at 15 lb. pressure would require 6 or 7 hrs. to obtain a 1/16-in. case, and without any apparent reason whatsoever would suddenly require 25 to 30 hrs. to obtain the same case, if it was obtainable at all. It was discovered that the entire difficulty lay in the variable moisture content of such gas.

The gas was then dried to a moisture content equivalent to saturation at 32 degrees F. This resulted in a cutting down of the amount of gas required for a given operation, but it also caused a large precipitation of soot. Further research, however, showed that if, at the beginning of each run, when the steel is up to temperature, 10 drops of water per min. for 6 min. were introduced into the hot retorts, a peculiar condition was built up on various portions of the surface of the steel parts which would not in any way affect the parts themselves, but acted as a powerful inhibitor of reactions which precipitated soot in the latter stages of the run.

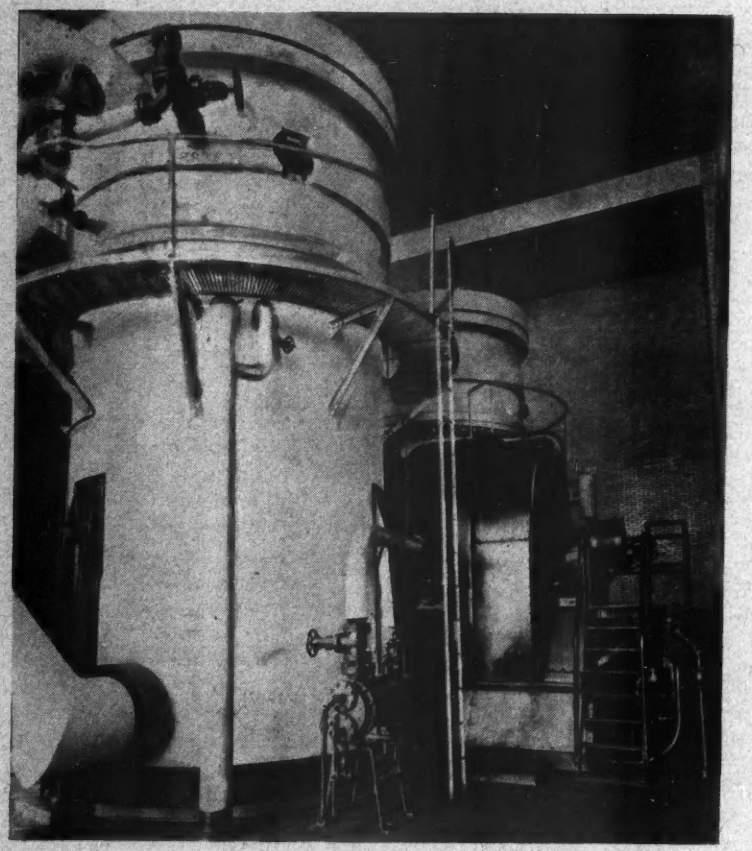
—*Metal Progress*

New type of retorts used in the process of carburizing steel with gas.

Another difficulty encountered was that the carburizing gas would not immediately purge itself from close proximity to the parts being carburized. After the carburizing process started a thin film of so-called dead gas seemed to adhere very tenaciously to the metal surfaces thereby slowing down the process considerably. This was overcome by using any of the heavy hydrocarbons in cycles, interposing an oxidizing gas such as air, water or CO_2 between these cycles or surges of carburizing gas when the supply valves for the latter were closed. Obviously the simplest and most easily controlled medium to use for this purpose is CO_2. The cycle is repeated over and over until the desired depth of case is obtained.

As far as the efficiency of this process is concerned, it still takes about five hours to obtain a 1/16-in. case at temperatures between 1,700 and 1,800 degrees F., and the amount of the carburizing gas will be directly proportional to the carbon concentration of such a gas.

Throughout the processes it is extremely important that the moisture content of all gases used be under absolute control at all times. A variation in the moisture will result in a considerably different carbon concentration in the outer edges. It has therefore been necessary to develop special instruments to check the moisture content of the gas issuing from the dryers and to indicate throughout the carburizing run the equilibrium conditions within the retort.



—*Scientific American*

A 10,000 kilowatt mercury vapor turbine generator unit showing end of generator and the mercury vapor condensers.

Mercury Vapor Power to the Fore

Condensed from Scientific American, *November 1931*

Very often some outstanding development will be announced, discussed widely for a time, and then, so far as the layman is concerned, it disappears from sight. If the development is meritorious, the silence is usually due to the fact that long years of experimentation are necessary to prove its full worth. The average man, however, does not realize this and is inclined to believe the worst.

This has been exactly the sequence of events in the case of the mercury vapor power generation scheme about which so little has been heard during recent years. This scheme has now proved not only commercially practicable but also more efficient than ordinary steam plants.

Briefly stated, mercury offers decided advantages over water in turbine operation because it boils at a much higher temperature. The efficiency of any heat engine may be increased by increasing the temperature range through which it works. One way to do this is to lower the temperature of

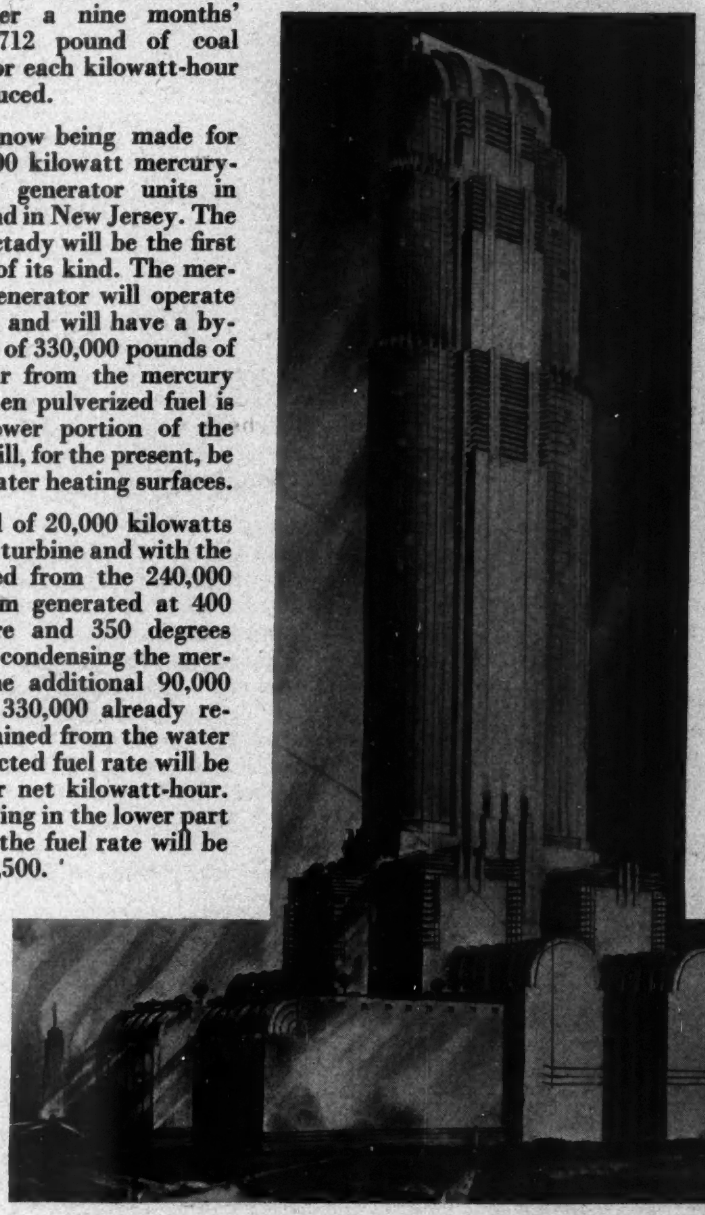
the exhaust and a second way is to raise the temperature of the supplied steam. It is for the latter reason that steam turbines have been constructed to operate at higher temperatures and higher steam pressures. At reasonably high temperatures, however, the pressure of steam becomes too great for convenient commercial operation. With mercury, high temperatures can be obtained without high pressure. For example, mercury vapor at 958 degrees Fahrenheit, has a pressure of 125 pounds gage while steam at only 569 degrees Fahrenheit has a pressure of 1,200 pounds gage.

Mercury vapor, obtained by boiling and vaporizing mercury over a fire, drives the mercury turbine just as steam drives a steam turbine in the ordinary system. A large part of the power generated from the mercury turbine is obtained at very high efficiency, since the exhaust vapors retain a great amount of heat which is used to produce steam in the mercury condenser at pressures which are in common use.

Records of the performance of a 10,000 kilowatt mercury turbine in operation since February 1930, show a substantial saving in fuel over usual steam generating equipment. The ease in starting and operating the apparatus, and the lack of appreciable noise and vibration is apparent. Over a nine months' period only .712 pound of coal was required for each kilowatt-hour of energy produced.

Plans are now being made for installing 20,000 kilowatt mercury-vapor turbine generator units in Schenectady and in New Jersey. The unit in Schenectady will be the first outdoor plant of its kind. The mercury turbine generator will operate at 13,800 volts and will have a by-product output of 330,000 pounds of steam per hour from the mercury condenser. When pulverized fuel is burned, the lower portion of the furnace walls will, for the present, be protected by water heating surfaces.

With a load of 20,000 kilowatts on the mercury turbine and with the power developed from the 240,000 pounds of steam generated at 400 pounds pressure and 350 degrees Fahrenheit, by condensing the mercury vapor (the additional 90,000 pounds of the 330,000 already referred to is obtained from the water walls), the expected fuel rate will be 8,800 B.t.u. per net kilowatt-hour. With water cooling in the lower part of the furnace, the fuel rate will be from 9,100 to 9,500.



The 2,000 foot superskyscraper of 1981.

—*Heating and Ventilating*

Air Castles are figments of the imagination, to be sure, but in the case of the skyscraper they have become actualities. And now the architect is visualizing the superskyscraper such as the one shown here.

It is predicted that fifty years from now New Yorkers will be living in gigantic structures 2,000 feet high, in an ideal climate as to sunlight, temperature, humidity and atmospheric purity, controlled by mechanical means. Fifty or sixty of these structures will house a population considerably greater than that now living on Manhattan Island. Each building would occupy a ground area of 400,000 to 500,000 square feet and would be at least half a mile from the next building.

The walls will be of metal or glass. The huge shaft of the building is devoted entirely to residential use with communal dining rooms on each floor to replace individual facilities for preparing and serving food. Artificial lighting transmits a highly efficient amount of ultra violet rays, the air is chemically pure and the temperature and humidity are always maintained at scientifically ideal conditions.

The base of the building is devoted to the businesses and activities supporting the residential portion of the building, which in reality is a complete city. The roof of the base portion of the structure is here shown planted but with the development of a braking device or the perfection of the gyroplane, it may serve as a landing space for aircraft.

Electric Busses operating with the same overhead lines as were formerly used for ordinary street cars are proving more efficient than electric trolleys or gasoline busses. The machines are able to maintain high schedule speeds at less expenditure than can either of its rivals. They load and unload passengers at the curb, and, in contrast to the gasoline-driven omnibus, have unlimited and reliable power, better lighting and heating, no exhaust fumes, and quiet, wear-resisting performance, since engine and gear noises are eliminated. Drivers find the trackless trolleys easier to handle; statistics show marked decrease in the number of accidents; and increased earnings reflect the popular approval of this quite recent development in electric traction.

The TECH ENGINEERING NEWS

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EDITORIALS

Whence the New Physics?

General Jan C. Smuts, President of the British Association for the Advancement of Science, is famous not only as a scientist, but as a statesman and soldier as well. It was, therefore, from an exceptionally broad experience in the affairs of the world that he drew the material for his presidential speech before the Association this fall. The result is a clear-cut picture of what science has come to believe to be the status quo of the world today; a picture which every thinking person should contemplate.

The gist of his argument is this: Common sense recognizes that the world is made up of three levels—matter, life, and mind. Science has, to within a few years of the present, studied each one of these levels as minutely as its methods would allow. But efforts to co-ordinate the material collected in each field into one single scheme met with little success because the relation between mind and matter and between life and matter seemed unintelligible. Therefore, science, because it could deal with the matter so much more effectively, tended to present an extremely materialistic picture of the world.

But Relativity and its associated theories in the new physics has overcome the old concept of matter, and reduced the scientific world-picture to a configuration in space-time. This space-time, while difficult to deal with experimentally, seems to play the role of organizer. It seems to co-ordinate the three distinct elements of the world—matter, life, and mind—into one harmonious scheme. Matter is the organization, life the organism, and mind the organizer. To quote General Smuts, "Matter, life, and mind may be but different stages of the same activity. Materialism has thus gone by the board, and the unintelligible trinity of common sense reinterpreted and transformed."

If the theory of relativity is to have as far-reaching significance in our picture of the world as General Smuts suggests, it is highly important that the theory be fully interpreted and developed as rapidly as possible. Those physicists and mathematicians who are laboring on the problem have more to seek than the formulae and abstruse deductions. From them, and from the new physics, we may expect a picture of no narrow mathematical importance, but one which will strike to the roots of philosophy and religion. We have not heard the last from Einstein.

Increased Student Liberty

Student government, after the numerous difficulties encountered in its establishment, is by now an accomplished fact in many colleges and universities. But we have not been content to stop at a type of political government wherein a portion of the student body controls the actions of the remainder with more or less of success and diplomacy. New steps have been taken and the individual student is being permitted to assume more control of his own actions which are of an academic nature. To cite an example, the student is being allowed to decide for himself whether or not he should attend classes. This concession on the part of the faculty

is being extended not only at Technology, to honor students in a few of the courses, but also at Wesleyan to the junior and senior classes in general. Encouragement is given to the movement by the report of the faculty that scholastic ratings have in no way suffered as a result of the experiment.

We of Technology and of every other reputable college are possessed of a serious purpose. The majority of students, therefore, is not easily to be deviated from the path of honest scholarship by frivolous amusements.

In such case there is every reason for an extension of the voluntary attendance idea to every course and in every class. We are, we hope, fully aware of the educational advantages within our grasp. Of a truth then, the faculty would scarce fail to be delighted by the abolition of compulsory attendance at classes. No more roll-calls, no tedious lists, no perfunctory lecturing to those "required to attend," and our professors could be sure of a genuine interest in every class under their instruction.

Appreciating an Education

It has been universally experienced that anything worth having is sometimes quite difficult to obtain. In all probability the very reason why a thing is deemed worth while is because it does offer resistance to acquisition. This is quite true of an education.

An education develops the mind; conditions the mind for grasping increasingly newer and higher ideas. It paves the way for research work and gives the student self satisfaction in his ability to act independently. To do these things, however, its true significance must be appreciated. Unfortunately there is a real lack of initiative and purpose among student bodies as a whole. This evil is traceable to the fact that money plays an important part in diverting the student's attention from his work and places the facilities for an education within such easy grasp that the student has the tendency to become indifferent towards it.

Appreciation comes only after a struggle to reach an end and maintain it. Thus it is that nine times out of ten the real value of an education is apprehended only by the student who has to work hard to get it. The disadvantage at which the financially poor student finds himself seems quite unfair, but after all it invariably turns out to be the best thing for him. If upon graduation day he is confronted with a large debt as the result of financing himself through school he is given the determination to make the most out of what he has acquired in the way of an education. The mere fact that financial debt foreshadows his efforts tends to give him greater momenta in accomplishing his purpose.

Elections

THE TECH ENGINEERING NEWS announces the election of the following men to its staff: to the Editorial Staff, Howard E. Bernhardt, Charles W. Bubier, William V. Corcoran, William R. Cox, Robert C. Madden, Frank J. Messmann, Henry J. Ogorzaly, and William W. Seary; to the Business Staff, Francis S. Doyle, George D. Fenton, Kenneth D. Finlayson, Arthur W. Gilbart, Morris Goodhart, Henry B. Kimball, Cecil E. Mann, Frank A. Nicoli, Carl W. Rahn, Daniel F. Shepard, William M. Watson.

ANTOINE LAVOISIER
1743–1794

The father of modern scientific chemistry was the only son in a rich family and as a young man he studied law, mathematics, geology, and meteorology. His early prominence is shown by the fact that he was elected a member of the Academy of Sciences at the age of twenty-five. He held the post of controller of munitions for sixteen years and administered it capably, but this was one cause for his subsequent death by the guillotine. Lavoisier fitted up his chemical laboratory at the Arsenal, where scientists from all over the world visited him. The domestic and psychological atmosphere which surrounded him there was as happy as could be desired. He reserved six hours a day for his scientific study and one whole day each week for his experimental laboratory work. "One should have seen him there to understand his clear reasoning, his great intellectual ability, his rare spirit." His industry was indefatigable but his largeness of vision and clearness of insight made him one of the outstanding intellects of the whole period.

It was Lavoisier alone who discovered the proper set of guiding ideas and allowed chemistry to begin its real progress. His work constitutes the true scientific revolution in chemistry. Stahl's phlogiston theory seemed at that time to offer at least a partial order in the general confusion of theories. The assumption that the mysterious phlogiston had negative weight was only one of the many absurdities of this theory. Fire and heat were being confounded with material masses. The time was ripe for Lavoisier to change the point of view and to develop an entirely new theory. His early experiments with boiling water and with the burning of diamonds brought into play his excellent use of the strict quantitative methods which eventually led to his greatest accomplishments. His basic theory of combustion, with all its revolutionary consequences, was formulated through his own experimentation and his own intellectual vision. In 1772 he wrote a sealed memoir which he deposited with the Academy of Sciences in which he made his first presumption against the phlogiston theory. The experiment that decided the fate of this old theory was one first performed by Boyle and others, but it was Lavoisier alone who saw clearly the simple facts that in the calcination of tin in the presence of air, the increase in weight was due to the combination with air. Priestley's discovery of oxygen gas and his realization that it supported combustion better than ordinary air supplied the missing link in Lavoisier's new system. The difference between oxygen and carbon dioxide was cleared up and the mechanism and significance of respiration was settled. It was then realized that the formation of acids was analogous to the process of combustion and calcination. The prominence of oxygen in acid formation suggested to Lavoisier its name of oxygen, or acid former.

Cavendish's discovery of the true composition of water led Lavoisier and Laplace to perform a like experiment, and their conclusions were announced in 1783. With the composition of water known, practically all the necessary tools for the analysis of inorganic chemistry were at hand. Lavoisier also started organic chemistry through his studies of the fermentation of sugar into alcohol and of the combustion of alcohol. The year 1789 saw the completion of the revolution which he had initiated in chemistry, as well as the beginning of the social revolution which shook the continent of Europe. Lavoisier published his "Traite elementaire de la Chimie" in which he expounded the new system of chemistry with his new nomenclature.

The less said about his death the better. The whole episode of his arrest, trial, and execution is characteristic of that brief nightmare of the French Revolution known as the period of the Terror. Lagrande wrote, "They needed but a moment to cut off that head, the like of which perhaps a hundred years will not suffice to reproduce."

THE TECH ENGINEERING NEWS takes this opportunity to extend to the Faculty, Student Body, Alumni and its many other friends its sincerest wishes for a Merry Christmas and a most Prosperous and Happy New Year.

Christmas Gifts

FOR MEN

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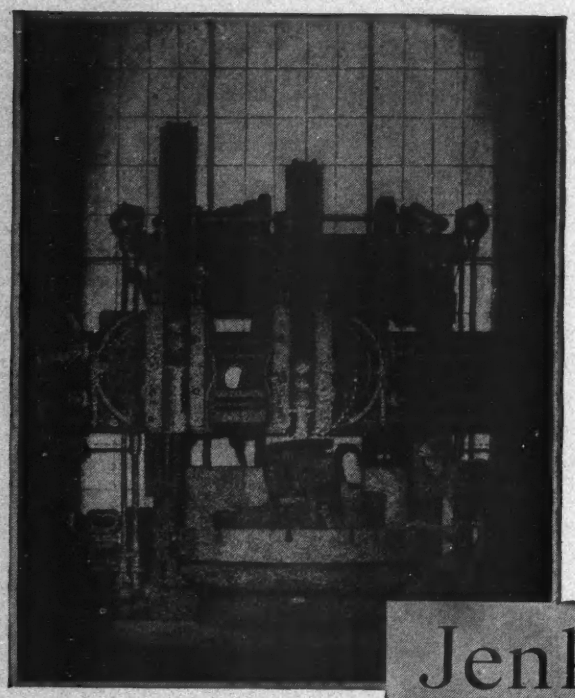
FIRE PROTECTION

(*Continued from page 210*)

To overcome these difficulties, a new head has been devised, substituting for the metal strut a small bulb of quartz filled with a liquid, having a small bubble of air imprisoned with the liquid. Since the coefficient of thermal expansion of quartz is very low, changes in temperature will not appreciably change the bulb volume. As the temperature rises, however, both the liquid and the bubble of air tend to expand. The liquid, exerting more pressure, finally forces the air to dissolve in it, against its natural tendency. As the liquid expands, it exerts a pressure against the quartz bulb and finally cracks it, releasing some of the internal pressure. This release of pressure allows the air bubble instantaneously to come out of solution. The sudden shock inside the weakened bulb causes it to shatter completely, opening the valve below. Since there is a very definite temperature at which this action occurs and there is no danger of softening the parts, the operating point of the heads can be set lower, usually around 135°F, making the system more sensitive to fires.

A supervisory association with central offices in many cities the country over provides continuous supervision of sprinkler systems. The sprinkler systems of those firms subscribing to its service are electrically connected to indicators in the district office of the association. If the system gets out of order this condition is automatically signalled at the central station and an inspector is dispatched to find the trouble and to correct it. Should a fire occur, this also is signalled at the central office, whereupon the fire department is dispatched to the premises. The circuits employed in the supervisory



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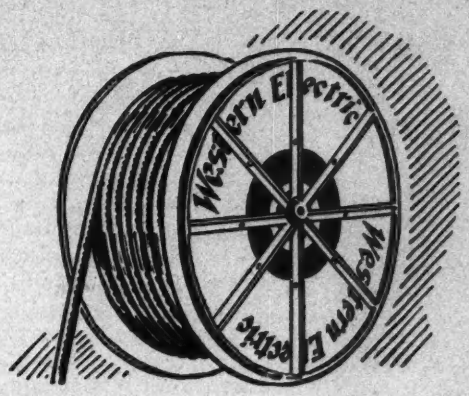

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service are closed circuits, and give a "trouble" signal when deranged, thus defeating the purpose of anyone who might seek to make the system inoperative in order to burn down a building.

While fires are still very common, the sprinkler has proven very efficient in reducing them both in number and in size. In certain classes of property, such as industrial plants where owners have readily installed automatic protection, the average loss per $100.00 of fire risk written by one insurance company has been reduced from 26 cents in 1850–1875, before sprinklers were known, to under 5 cents for the period 1896–1930 when sprinklers have been more common. A fire map of Boston also shows that fires avoid the sprinklered areas of the city to a marked degree.

MODERN UNIVERSE

(*Continued from page 207*)

the heavens, dividing it apparently into two parallel streams from the constellation Cygnus to Centaurus far in the south. A black "hole" in the Milky Way near the Southern Cross is the "coalsack" of the early adventurers in the southern seas. These are prominent examples of the effects of obscuring dust clouds. Some of the nebulosity, such as the great nebula in Orion, are faintly luminous. It is believed that they are lighted up by neighboring stars, perhaps in the same way that our upper atmosphere is stimulated by the sun during the display of aurora.

The problem of the construction of the universe is primarily that of determining the distances of the celestial bodies. Given the distances, and of course the directions, it is possible to make a model showing everything in its proper place. In its simplest form the problem of measuring stellar distances is a problem of triangulation. The base line is the diameter of the earth's orbit, some 186 million miles in length. As we revolve around the sun, the nearer stars are slightly displaced relative to the more distant ones. The problem is to observe this parallax effect on the different stars,

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and then to calculate their distances by trigonometry. It appears simple enough, but the triangle is highly ill-conditioned. Even the nearest star is 25 million million miles away. Imagine the difficulty of measuring the distance of an object 25 miles away using a base line only a foot long. And this is the simplest case. Yet astronomers have succeeded in measuring by direct triangulation the distances of many hundreds of stars in the sun's vicinity, that is to say, within a distance of 200 light years. Beyond this distance, which is only a step into the depths of space, the method fails, because the parallax effect becomes too minute to measure. A more powerful method of measuring distances was needed before the exploration of the universe could make much progress.

Fourteen years ago, Dr. Harlow Shapley, Director of the Harvard Observatory, then astronomer at the Mount Wilson Observatory, solved the great problem. He showed how the Cepheid variable stars can be utilized in the measurement of celestial distances, and successfully applied the new method in the study of the distribution in space of the globular star clusters. Shapley's conclusions demonstrated for the first time the enormous size of the system of the Milky Way, and prepared the way for the extension of explorations beyond it into the vast spaces populated by millions of exterior galaxies.

Until eight years ago the problem of the construction of the universe was concerned with the galactic system. There was no certain knowledge of anything beyond the Milky Way. In 1923, Shapley at the Harvard Observatory demonstrated that the irregular assemblage known to astronomers as N.G.C.6822 has a distance of the order of a million light years; and in 1925, Hubble at the Mount Wilson Observatory, making use of the Cepheid method, showed that some of the great spirals, such as the "great nebula" in Andromeda, have distances of this order, so that they lie far beyond the Milky Way. These two astronomers were the pioneers in extending the universe past the Milky Way into hitherto unimagined depths of space.

In the meantime, studies of the exterior galaxies have proceeded vigorously. Hubble recently estimated that 30 million are within reach of the 100-inch telescope, and that the faintest of these are 300 million light years away. There are at least three kinds, namely, spirals, irregular systems such as the nearby Magellanic Clouds, and the so-called elliptical nebulae which have not been resolved into stars. The exterior galaxies have diameters of thousands and often of tens of thousands of light years. Many of them are gathered into larger systems, the supergalaxies. To the limiting distance of their visibility they give no indication of thinning out. But we may well believe that they do thin out eventually, that they constitute a vast system whose form and dimensions must remain unknown for the present. And we may perhaps imagine that this colossal structure is a unit in a system still more vast.

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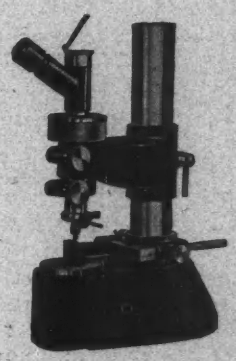

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CHEMISTRY

(*Continued from page 209*)

Since President Crafts resided in Paris for over twenty years, carrying on chemical researches before he became head of the Department of Chemistry of the Institute in 1892 and then president in 1897, it seems likely that he may have secured the painting in Paris—there is some evidence that it was painted in France and not Germany—but none of his family have any recollection of the picture. A search of the presidents' reports over a period of years shows no record of its acquisition by purchase or gift, and when we consider the condition of the treasury of the Institute at that time it is more likely that it was a gift and not a purchase.

Anna Lea was an artist of considerable repute; a canvas by her hangs in the Tait Gallery in London. We are fortunate in having this painting; but how did we get it?

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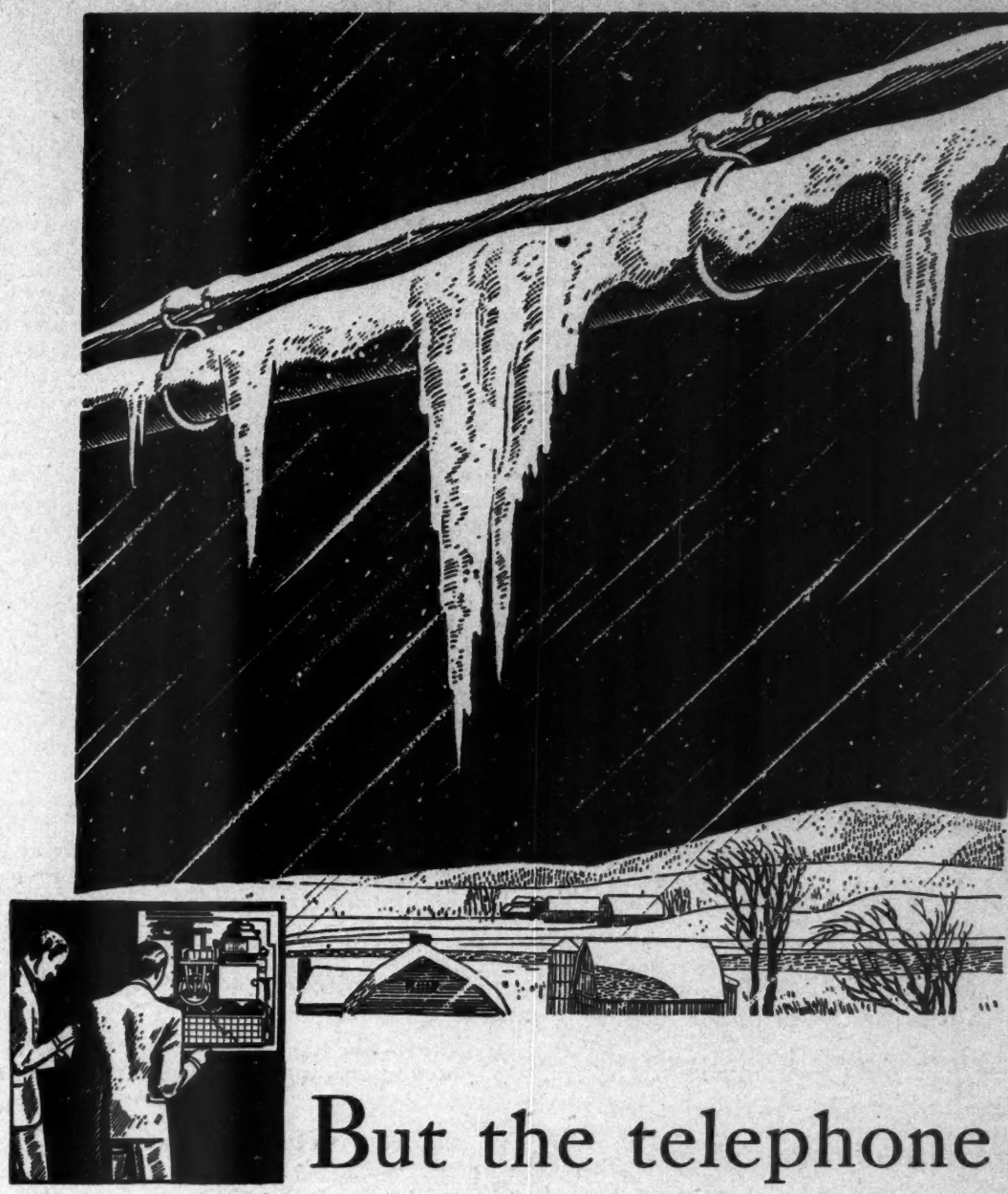

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PREVIEW

"WHAT, in your opinion," we asked Colonel Starr, "are the opportunities for a young engineer in Russia today, and what has Russia to offer him for a future?"

In reply, Col. Clarence T. Starr, mining engineer, has written his article, "Opportunities in Russia?" For the past three years he has been working in the U. S. S. R., managing the affairs of a firm of consulting engineers. He gives a very graphic and illuminating picture of the status of American engineers under the Five-Year Plan, the conditions under which they work, what they are expected to do, and the inconveniences which they must endure. Finally, he gives his opinion of what a young engineer may expect from Russia in the way of a future.

ENGINEERING applied to a hitherto unopened field, the human being, is described in the interview with Johnson O'Connor entitled, "Human Engineering." That engineering methods of research and careful, logical trial, can be applied to the study of such complex quantities as the human equation is in itself an interesting fact, but the results which have come from the application of logically worked-up tests are in some cases indeed surprising. The "slow-but-sure" person is an exception to the rule, while the quick man is more usually accurate. Major executives all possess wide vocabularies. Tests can actually be made to see if a person has any aptitude for engineering or for business or for neither. These are only a few of the many things which Mr. O'Connor has discovered, and which are briefly sketched in the article, "Human Engineering."

RUBBER, which for many years defied chemists to analyze its composition, has at last yielded to the synthetic chemists' patient prodding and is now being made on an industrial scale in a form which is for many uses superior to the natural product. How this is done is briefly described by Mr. H. W. Underwood, Jr., of the Department of Chemistry, in his article, "Recent Uses of Catalysis." Following this he takes up the making of sulphuric and nitric acids, important for a thousand different processes, the hydrogenation of petroleum and coal, and the synthesis of organic compounds.

MAKING night scenes for motion pictures in broad daylight and taking pictures at 310 miles distance, are two of the many items described by Mr. H. Parker of the Kodak Research Laboratories in his article, "Color Photography." The story of the long search for materials having the same range of sensitivity in the spectrum as the human eye is told, and some of the latest developments in the always interesting field of color photography related.

FEW people realize the extent to which electricity has been applied to the running of railroads. A scant forty years ago the first project for the electrification of the short Nantasket Beach Line was undertaken, and a little over twenty-five years ago electricity was first applied to the steam railroad. Since then, its use has spread rapidly, especially in mountain and urban districts. Its growth is described by E. Harold Anderson, '32 in "The Electric Horse."

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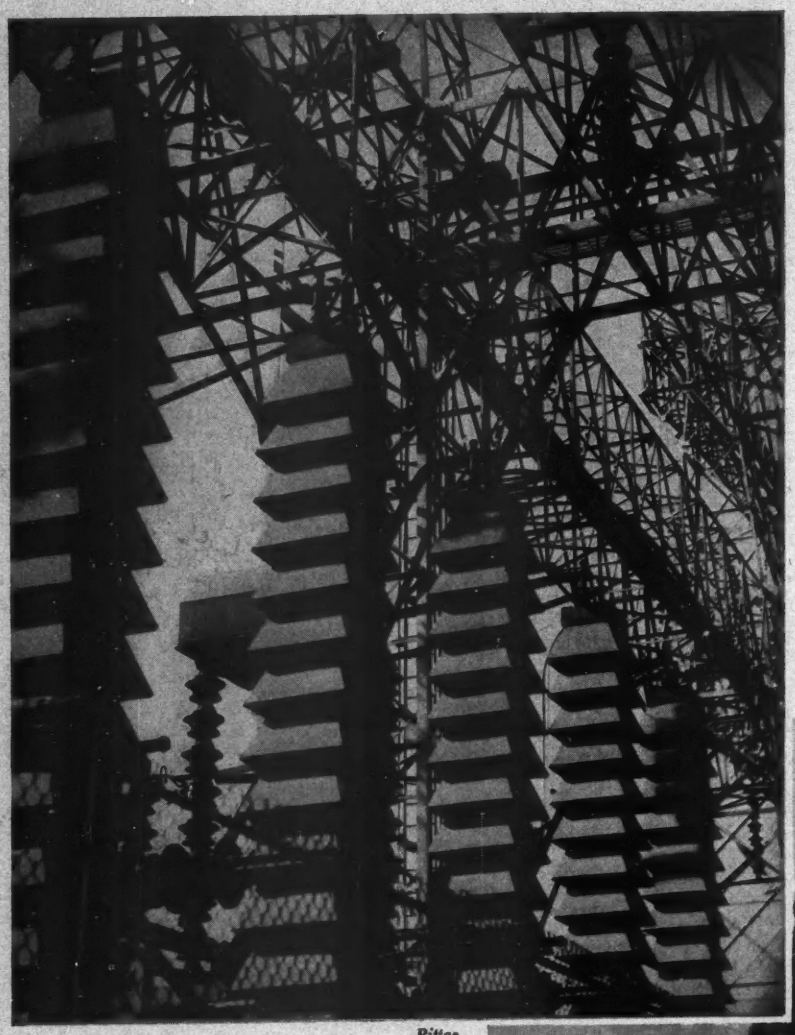

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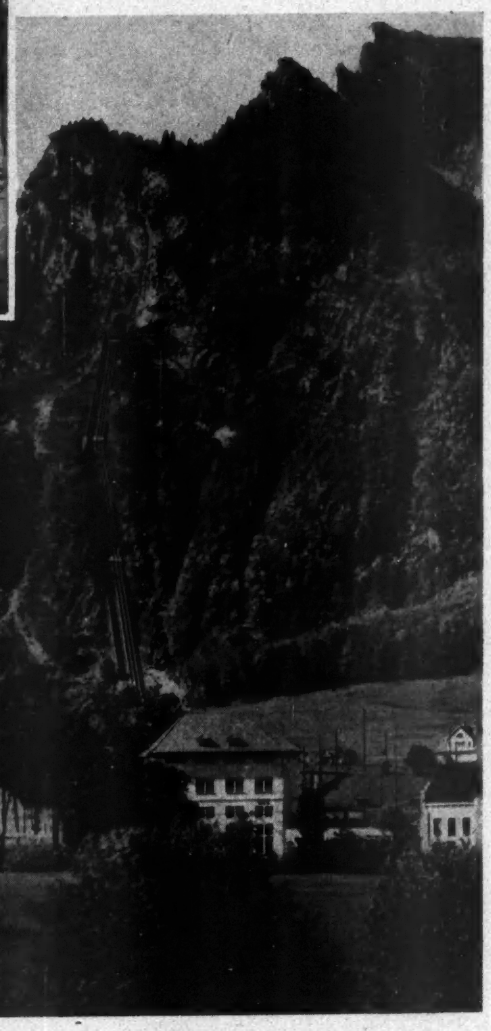

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